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Developing an academic programme of machinery maintenance for ship crew and shore personnel in Mozambique

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WORLD MARITIME UNIVERSITY

Malmö, Sweden

**DEVELOPING AN ACADEMIC PROGRAMME
OF MACHINERY MAINTENANCE FOR SHIP
CREW AND SHORE PERSONNEL IN
MOZAMBIQUE**

by

PAULO ANDRÉ TOVELA

Mozambique

A dissertation submitted to the World Maritime University in partial fulfilment of
the requirements for the award of the degree of:

MASTER OF SCIENCE

in

MARITIME EDUCATION AND TRAINING (engineering)

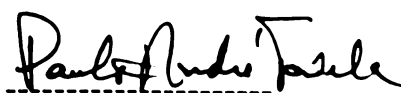
1996

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DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified, and that no materials is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the university.



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Malmö 18th October 1996

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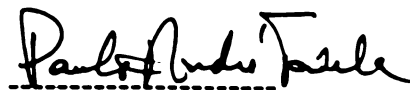
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ABSTRACT

Developing an academic programme for ship machinery maintenance

Degree: M Sc.

The dissertation is a study of the ship machinery maintenance programme, discussing the different methods of its implementation and practical use.

The Mozambican maritime industry is covered with emphasise on the main contributors to the Gross Domestic Product of the country.

Although the shipping industry is still underdeveloped compared to other industries in the country, the situation of the shipping sector is adequately taken up in this dissertation.

The types of maintenance such as the planned, preventive and corrective maintenance are examined. More coverage is done on maintenance as planned , and the Norwegian planning and maintenance (TSAR) system is likewise described and evaluated.

Programmes for education at the second and chief engineer levels are examined based on International Maritime Organisation standards.

Procedures and guidelines were developed to incorporate the maintenance work in the academic programme for engineers in the nautical school.

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LIST OF ABBREVIATIONS

AC	Alternative Current
CAL	Computer Aided Learning
CFI	Cost Free Insurance
DC	Direct Current
DSC	Drewery Shipping Consultants
EMARNA	Estaleiro de Manutenção e Reparação
ENABE	Estaleiros Navais da Beira
ENAMA	Estaleiros de Manutenção Naval
EU	European Union
FOB	Free on Board
GESTNAV	Gestão de Estaleiros Navais
HO	Heavy Oil
IDA	International Development Agency
ILO	International Labour Organisation
IMLA	International Maritime Lecturers Association
IMO	International Maritime Organisation
ISM	International Safety Management
ME	Main Engine
M T	Metical
NAVIQUE	Mozambican Navigation Company
RO-RO	Roll on Roll off
SADCC	Southern African Development Co-ordination Conference
SAFEMAR	Serviço de Administração, Fiscalização e Segurança Marítima
SM	Ship Management
SMS	Safety Management System
STCW	Standards of Training, Certification and Watchkeeping

LIST OF ABBREVIATIONS

TPC	Tonne Per Centimetre
UK	United Kingdom
UN	United Nations
USA	United States of America
USSR	Union Soviet Socialist Republic
WMU	World Maritime University

CHAPTER I

INTRODUCTION

Since the period of its independence Mozambique has been involved with the education and training of seafarers who man the national fleet, normally in coastal navigation along the Mozambican Channel to the professional development of officers in the merchant navy in Mozambique has produced many competent seafarers, although not in a always systematic way and with varying individual qualifications.

The training of seafarers is a shared in Mozambique and throughout the world responsibility of mariners themselves, shipping companies, the training establishments, maritime authorities and the International Maritime Organisation (IMO). The use of new programmes and strategies on ship machinery maintenance has not been assimilated easily into the traditional seafarers training programmes. This has been the case in Mozambique. The rapid technological development in the last twenty years has demanded more stringent strategies for ship machinery maintenance, such as computer based filing and ordering of spare parts, labelling of spare parts, maintenance procedures and maintenance execution on board ships and the working condition monitoring systems. Their use, and the corresponding training programmes, seem to have developed in specialised way, often depending on the initiatives of individual training establishments working with various shipping companies.

Marine accidents around the world often involve experienced and competent seafarers. Further, most accident investigations show a chain of error involving these seafarers. At the 9th International Maritime Lecturers Association in Kobe, Japan, 1996, it was pointed out that not all the 80% of marine accidents should be blamed on crew members on board ships, but that there is a portion of it linked to defects connected to the design of ship equipment from the shipbuilders and problems like

inaccurate weather forecasting. The implication is that additional or special professional development and training is not always provided to seafarers, E.E. Mitropoulos, IMLA (1996).

Education and training of seafarers has become a major focus as one method of addressing these concerns. It follows that there is a need for developing effective academic programmes with ship machinery maintenance as a priority in Mozambique.

The dissertation is organised in the following chapters: Chapter 1 it is an introduction to the educational and training needs of seafarers. Chapter 2 gives a brief description of the Mozambican main industries, the background and the prospects on the actual investment from outside. Chapter 3 is more concentrated on the shipping industry, describing briefly the size of the national fleet and defining the main navigation companies in the country. Chapter 4 considers the shipyards in Mozambique, their role in machinery maintenance and repair. Chapter 5 defines the International Safety Management code with regard to ship machinery maintenance, guidelines on education and training of the staff within an organisation. Chapter 6 describes types of machinery maintenance: planned maintenance, preventive maintenance and corrective maintenance. Chapter 7 is focused on developing a plan for the implementation of the IMO Model courses for education and training of seafarers, steps to be taken on the assessment of the course within the Nautical school, national authorities, and the full implementation of the educational project

Suggested ways to improve the education and training of marine officers, are made. These take into account the full range of knowledge and skills that should be acquired by trainees within the context of international codes, and agreements which apply maintenance strategies. These are placed within the context of the present conditions in Mozambique.

Efficient and effective procedures of ship machinery maintenance are explained, indicating how energy consumption can be reduced and capital costs can be kept under control, leading to good end quality can be achieved.

CHAPTER II

MOZAMBICAN INDUSTRIES

2.1 GENERAL

According to Africa South of the Sahara Mozambique has enormous industrial potential..However the lack of skilled manpower and financial inputs for industrial development makes the country one of the poorest in the southern region of Africa.

Mozambican industries are mainly devoted to the processing of primary materials, and it remains dependant on South African industrial products.

About 47% of Mozambican manufacturers are located in and around the capital Maputo. This is because of the civil war, which was particularly intensive in the central and northern regions of the country. The government is encouraging decentralisation towards those regions, in a way to facilitate production for the benefit of the local population.

Export-oriented industries have been established with the support of Portugal, South Africa, Italy and the UK. The food processing business has formed the traditional basis on this sector and includes sugar refining and cashew-and wheat-processing. Textile production and brewing gained in importance during the 1980s (Africa South of the Sahara 1996).

Other industries include cement manufacturing, fertilisers and the production of agricultural implements. Cotton spinning and weaving are undertaken in northern and southern provinces. Mozambique imports all its gas and petroleum and has considerable mineral resources for exports. These are discussed below:

2.2 GAS AND PETROLEUM

Mozambique imports all its petroleum supplies. The Maputo refinery has an annual capacity of 800,000 tons of crude oil; production was 683,000 tons in 1981, compared with 518,716 tons in 1974, according to Africa South of Sahara. Petroleum prospecting has been actively pursued by US, French, German and South African companies, both offshore near the Rovuma river basin and Beira and on the mainland, but so far only gas has been found. Extraction of gas from the Panda field in southern Mozambique began with the assistance of a US\$ 30 million loan from the World Bank agreed in April 1994. In recent years a critical shortage of foreign exchange has drastically reduced Mozambique's imports of crude petroleum, and severe shortages of fuel have ensued. These shortages are blamed on the actual depreciation of the national currency.

2.3 MINING INDUSTRY

Mozambique has considerable mineral resources, although exploitation had been limited by internal unrest, Africa South of Sahara(1996). The value of mineral exports was US\$ 1.1 million in 1987, \$2.4 million in 1988 and \$1.0 million in 1989. During 1991-93 mining contributed a constant 0.2% of GDP. In 1994 output increased to an estimated \$19.8 million. The government has aimed to encourage foreign investment in the minerals sector, and during the period 1986-89 foreign mining investment in Mozambique increased from \$5 million to \$50 million as a result.

There are confirmed coal reserves of about 6,000 million tons, but so far output has remained relatively low. The Moatize coal mine, has an annual production capacity of 600,000 tons, although output was only 84,500 tons in 1989 (compared with 574,800 tons in 1975), owing to a lack of facilities for transporting the coal to Beira Port.

Exports of coal from Moatize declined from pre-independence levels of some 100,000 tons per year to only 9,000 tons in 1986 during the internal unrest. Coal exports declined from 19,000 tons in 1990 to 400 tons in 1993 owing to flooding in the Moatize mines. However, there are plans to revive the industry, with a new coal-

handling terminal at Beira Port increasing annual capacity from 0.4 to 1.2 million tons.

Renovation work on the railway to the port, repeatedly delayed as a result of the security situation, resumed in July 1990. The European Community was providing funding of \$72 million for the project. The government signed bilateral agreements which envisaged an increase in annual coal production levels to about 3 million tons by 1995. The rehabilitation project envisaged foreign investment in mining projects, and in railway and port infrastructure work. The loans were to be repaid in coal. An agreement worth US\$ 700 million over seven years for coal prospecting.

2.4 RESERVED MINING

Mozambique has significant reserves of tantalite, but only small quantities are exported because of a lack of transportation to the hinterland. There are deposits of ilmenite in the area north of the mouth of Zambezi river.

The mining of iron ore began in the mid-1950s and the production of ore averaged about 6 million tons annually in the early 1970s. Production was disrupted by the civil war and ceased altogether between 1975 and 1984. At present, output is stockpiled and the resumption of exports of iron ore depends upon the eventual rehabilitation of the rail link between the mines at Cassinga and the coast. A major deposit of 360 million ton estimated reserves exists in the Nampula province.

Bauxite is mined in the Manica area; in the early 1990s several thousand tons annually were exported direct by licence to Zimbabwe. Further deposits near Tete were reported to be awaiting the completion of the Cahora Bassa power complex to be processed in Vila Fontes on the Zambezi. New deposits of manganese, graphite, fluorite, platinum, nickel, radioactive minerals, asbestos, iron, diamonds and natural gas (of which there are confirmed reserves of about 60,000 million m³) have been found.

The production, transporting and port facilities connected with the exploitation of the above resources are presently being rehabilitated. It will take more time and investment to normalise for production and export.

2.5 SECONDARY INDUSTRIES

Glass, ceramics, paper, tyres and railway carriages are produced in Mozambique.

Mozambican statistics show that industrial output may have fallen to less than 50% of its pre-independence level, owing to the exodus of skilled Portuguese workers, shortages of imported raw materials and spare parts, and the disruption to transport systems caused by the civil war. The national plan of 1983-85 aimed to encourage small-scale industries, placing emphasis on the production of basic consumer goods and of import substitutes, using local materials. In 1990 the International Development Association (IDA) provided US\$ 38 million for the rehabilitation and promotion of small-and medium-scale enterprises.

Table 2.1 Principal commodities (US\$ '000)

Imports c.i.f.	1988	1989	1990
Consumer goods:			
Foodstuffs	176,298	173,629	253,924
Other	104,597	155,927	83,888
Primary materials:			
Chemicals	48,547	52,185	31,953
Metals	35,465	42,472	97,723
Crude petroleum and petroleum products	61,104	71,523	95,860
Other	70,893	81,693	97,723
Machinery and spare parts	101,183	87,509	83,628
Capital goods	137,513	142,736	200,736
Total	735,600	807,674	877,520

c.i.f. — cost insurance freight

(Source: UN, *Monthly Bulletin of Statistics*, 1994)

These enterprises resulted in the improvement of local production and the country is now becoming less dependant on imports for most of its basic consumer goods.

2.6 EXTERNAL TRADE

2.6.1. PRINCIPAL COMMODITIES

Mozambique imports many of its consumer goods which are mainly transported by rails and ships.

Statistical surveys carried out in the years 1988, 1989 and 1990 by the UN shown in Table 2.1, show clearly that the country's import have oscillated among the main products. Foodstuff imports for instance increased by US\$ 77,626,000 between years 1988 and 1990, which was due either to depreciation of the Mozambican currency against the American dollar (12,000 MT = US\$ 1, in 1995), or due to the cease fire period, when more food was needed to feed those people going back to Mozambique from their refuge in the neighbouring countries.

Chemical imports increased in 1989, followed by a quick decrease in 1990, as in the Table 2.1. Despite that the Mozambican money was still under heavy depreciation. This was because of rapid developments in the national chemical industry, based on the construction of more chemical industries around Maputo.

The most significant improvements were recorded in the machinery and spare parts sector. By the late 1980's the country decided to adopt a free market policy which allowed for the creation of free enterprise companies. From then small companies were created in Mozambique from this time on. Most of machinery used at that time within the country was based on old fashioned technology and no spare parts were available from outside. This lack of equipment led a large number of companies to adopt innovative practices in ways to solve some of their machinery problems. At the same time Mozambique was starting to buy new, technically advanced machinery from countries within Europe.

2.6.2 EXPORTS

Mozambique being a coastal country, exports most of its sea resources. These include shrimps, lobsters and prawns. Cashew nuts, sugar, copra and raw cotton are also in the group of main exported products, and are the products of the country’s agriculture. Table 2.2 gives the figures of Mozambican exports between 1991 and 1993.

The export sector shows a decrease in most of the above mentioned products, excluding shrimps, prawns and raw cotton.

Because of the actual increase of free enterprise industries in the country and problems collecting data, certain amounts of exported products may not have been recorded. The decrease in some exports may have been caused by another reason like the fear of landmines, which has been responsible for the lower collection of nuts, putting in danger the lives of people involved.

Table 2.2 Total Exports (US\$000)

Exports f.o.b.	1991	1992	1993
Cashew nuts	16,033	17,592	8,151
Shrimps, prawns, etc.	60,779	64,550	68,793
Raw cotton	8,777	10,805	11,055
Sugar	9,765	6,655	-
Copra	4,657	4,188	2,500
Lobsters	2,814	4,885	3,188
Total (incl.others)	162,350	139,304	131,899

f.o.b.—free on board

(Source: UN, *Monthly Bulletin of Statistics*, 1994)

2.7 PRINCIPAL TRADING PARTNERS

2.7.1 IMPORTS

Mozambique’s principal trading partners are long-standing in the country’s history. At its independence (in 1975) Mozambique decided to adopt the socialist system and

the country was forced to trade within the former socialist block countries, where the former USSR, followed by the former German Democratic Republic, were the leading countries, amongst others .

Table 2.3 shows the variation on imports as per trading partner country's between the years 1987, 1988 and 1989.

Table 2.3 Total Imports (US\$'000)

Imports c.f.i.	1987	1988	1989
France	35,558	29,200	32,789
Germany, Democratic Republic	8,677	17,093	29,140
Italy	85,023	68,092	48,355
Japan	34,581	24,011	45,309
Portugal	31,049	42,627	55,130
South Africa	85,809	110,179	187,652
Sweden	27,653	28,875	24,406
USSR	54,896	73,228	78,842
United Kingdom	29,228	39,750	38,533
USA	62,888	6,222	57,279
Total (incl.others)	642,000	735,600	807,676

(Source: UN, *Monthly Bulletin of Statistics*, 1994)

The country has been importing more from South Africa Republic although it is not entirely reliant on South Africa.

2.7.2 EXPORTS

Regarding exports, as indicated in Table 2.4, Mozambique's principal trading partners are Spain and South Africa.

The country is involved in exporting fish and shrimps to Spain, through international agreements which allows fishing within Mozambican waters. On the same basis the Japanese are involved with shrimp fishing.

Table 2.4 Exports as trading partner (US\$ '000)

Exports f.o.b.	1990	1991	1992
Japan	13,092	19,635	13,163
Portugal	7,061	9,745	18,221
South Africa	8,868	14,148	23,033
Spain	22,634	31,238	41,028
USSR (former)	2,635	4,580	24,995 *
USA	14,553	21,409	18,610
Total (include. others)	126,427	162,350	139,305

*Exports to Russia only

(Source: UN, *Monthly Bulletin of Statistics*, 1994)

Exports to the USSR decreased drastically in 1992 because of its political and economical disintegration, although Mozambique is still exporting to the Russia Republic.

Other types of industries are dealt within separate chapters. The shipping industry is covered in detail in the following chapter.

CHAPTER III

SHIPPING INDUSTRY

3.1 MAIN PORTS

Fig. 3.1 shows Mozambique and its coast line, where the main ports are Maputo, Beira, Nacala and Quelimane. About 6.2 million tons of cargo were handled in 1991 in these main ports. The modernisation and expansion of the port of Beira, which began in 1991, was completed in 1994. The construction of a new petroleum terminal doubled the port's capacity, thus facilitating the transportation of petroleum products along the Beira corridor to Zimbabwe. Rehabilitation of the port of Maputo was completed in 1989, as part of the Southern African Development Co-ordination Conference (SADCC) transport programme.

According to Africa South of Sahara, repairs to the port of Nacala, damaged by a cyclone in early 1994, were costly. In late 1994 the port was reported to be operating at only 25%-30% of its capacity. Foreign assistance was being sought to finance repairs.

In Mozambique there is no railway link in the North South direction and where the air transportation system is rare. Comparing road transport to sea transport, this last is the more economical.

3.2 MARKET FLEET AND ITS DISTRIBUTION

The national maritime transport activity is performed by less than 10 general cargo vessels and one passenger vessel of 3500 dwt. These vessels are engaged in the coastal trade. A considerable number of ferry boats operate on short routes. Other small passenger carriers operate up and down the rivers and lakes. Barges are used in the transportation of general cargo and dredged products (sand, gravel and mud). Small product carriers, naval ships, dredges, tugs and other craft are involved in port services.

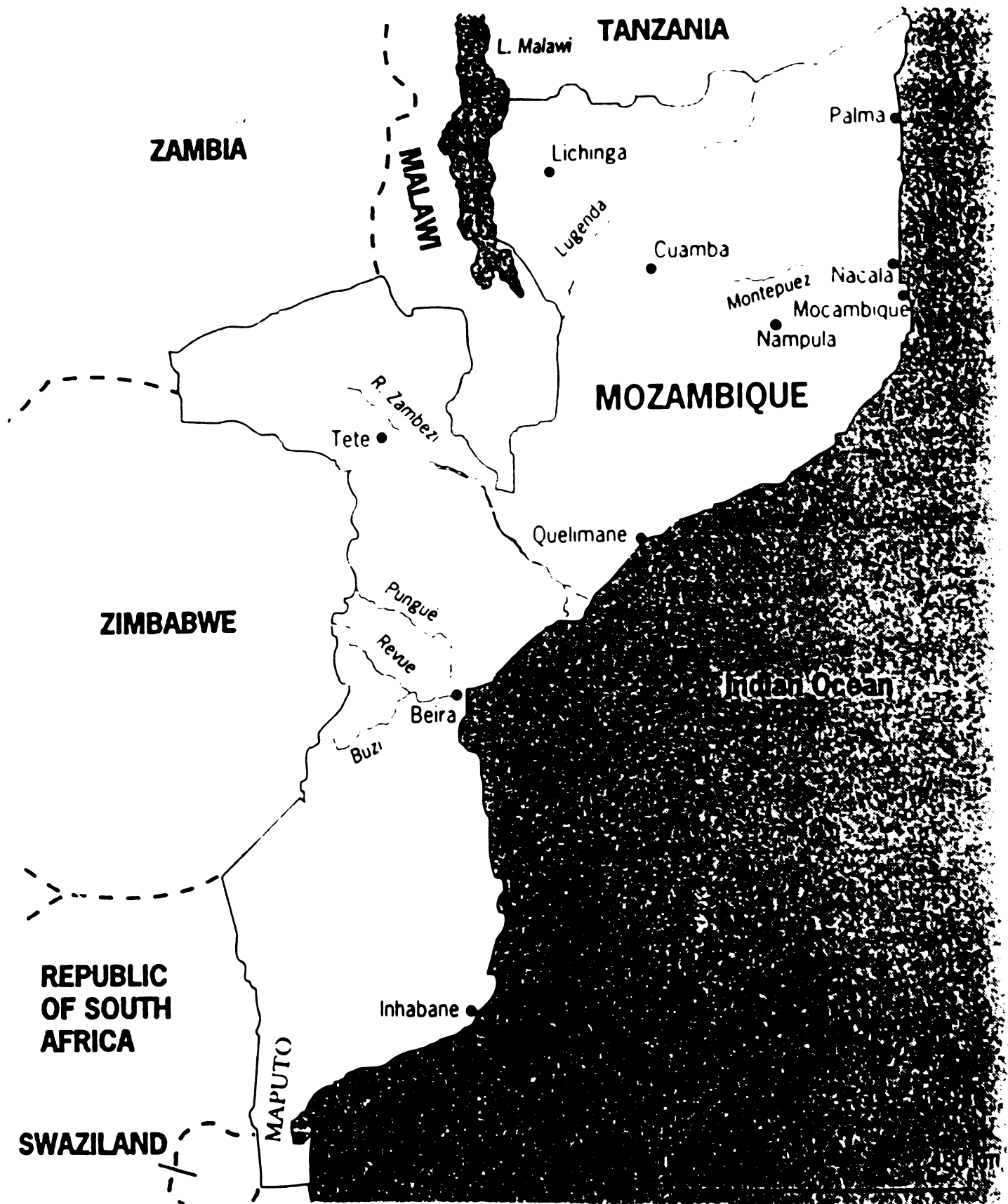


Fig 3.1 Mozambican Major Ports
 (Source: *Africa Review 1996*, World of Information)

Table 3.1 shows the detail of ships in numbers, gross tonnage and age, operating in Mozambique.

The national fleet is made up of many different kind of ships which are mainly used on fishing activities, cargo carrying and towing/pushing jobs. Although from the Table 3.1 the total number of fishing vessels looks higher than the rest, is because the fishing fleet is composed of small size ships and therefore their combined gross tonnage is smaller as well. The fishing fleet is distributed from north to south according to the catching zones and landing jetties/berths located at Maputo, Beira, Quelimane and Angoche (nearly a hundred nautical miles south of Nacala Port) where there are commercial freezer facilities.

Cargo carrying ships are mostly owned by the national navigation company (Navique) with head offices in Maputo. Navique is the only enterprise company performing liner services for carrying cargo and passengers, mostly along the Mozambican coast although its ships sometimes call at regional ports, such as Durban, Dar-es-Salam and Mombassa, in South Africa, Tanzania and Kenya

The company now owns 10 vessels and is under the direction of the Ministry of Transport, reporting directly to the Deputy Minister for the Merchant Marine. Most Mozambican marine cadets sail on board vessels owned by this company for training purposes

Navique is now facing internal problems to keep its fleet operational. Is on board Navique ships owned most trainees from the Nautical School of Mozambique get their on-board training job. There has therefore been a lack of facilities for those trainees.

Towing/pushing vessels are owned by the railways company operating closely with the port authorities supporting berthing/unberthing operations in the harbours and other activities. Towing vessels are spread through out the main ports in the country. There is no any employment opportunities likely to attract graduates from the Nautical School with the towing company which employs its workers itself.

There is one small tanker used for the transportation of oil from the Maputo refinery or Durban (South Africa Republic) to small ports along the Mozambican coast.

In addition to the above mentioned floating units, a foreign fleet of 33 ships is involved in diversified activities along the coast. This fleet enjoys advantages in the local market since the national fleet is not performing effectively.

The age of a ship is a function of its need for repair and maintenance, and this is a reason for the frequent stoppages within the national fleet.

Most national ships do not comply with the relevant rules of the international community.

The national company has been scrapping some of its older vessels, and this procedure has brought about job losses as a jobless situation to employees, because no additional ships have been acquired to replace the scraped ones.

Table 3.1 Mozambican ships

	No.	GT	Age
Passenger RO-RO Cargo	1	1879	40
Towing Pushing	12	5135	27
General cargo	10	8652	23
Fish catching	75	18064	18
Other activities	1	837	5
Other fishing	1	678	4
Oil	1	366	48

	No.	GT	Age
Cargo carrying ships	12	10915	27
Ships miscellaneous activities	89	24714	19
Totals	101	35629	20

Source: Shipping world statistics, 1994 Lloyds' registry

3.3 SUPPLY OF SEAFARERS

An analysis of the world-wide supply of seafarers The International Shipping Federation (BIMCO, 1990), has shown that Mozambique makes no contribution to the world supply of seafarers. This is because people trained in the country are directly employed within national companies. Mozambique is in a situation which the supply of seafarers is equal to the country's demand.

Table 3.1.a shows clearly this difference within a chosen number of maritime nations. Mozambique has not been heavily involved with seafaring matters in earlier history. It is known that national ratings were commonly used on board Portuguese ships, under the jurisdiction of Portugal, serving the colonial interests.

According BIMCO, Africa contributed with 3% to the 1.2 million world supply of seafarers in 1990. In the same year Mozambique was employing nearly 80 marine officers who were categorised on the levels of Captains, Chief engineers 2nd engineers and mates in the coastal trade. There was around 90 rating personnel employed as well.

There has been interest from outsiders in acquiring the few unemployed Mozambican officers, but the contract policy is highly regulated in the country and the maritime authority does not look on this favourably. This is opposed to the actual jobless situation in the main national company, which employs a great percentage of officers within the country. Maritime English may be considered as another obstacle to the internationalisation of the Mozambican man-power, the country still using Portuguese as the official language.

From the Table 3.2.b it can be seen that the demand for seafarers until year 2000 is not expected to change to a great extent. However these figures presented are likely to increase, because of the increase in the level being awarded to maritime education and training institutions within the country. In this regard there will be more incentives to students for the Nautical School and this may dictate the necessity of

changes in the employment contract policies. This may give the opportunity to graduates to get job on foreign vessels, or to take up employment off-shore within maritime related companies in the country.

Table 3.1.a Supply and demand differences by flag for 1995

	Supply: 1990 stock less wastage		Forecast -Demand		Difference Supply-Demand	
Flag	Officers	Ratings	Officers	Ratings	Officers	ratings
Philippines	27367	85739	11865	14126	15503	71613
Nigeria			20	23		
China	16932	45962	32348	67828	-15416	-21866
Portugal	322	1316	773	918	-451	397
Mozambique			87	99		

Source: Institute for Employment Research, 1990

Table 3.2.b Supply and demand differences by flag for 2000

	Supply: 1990 stock lees wastage		Forecast Demand		Difference Supply-Demand	
Flag	Officers	Ratings	Officers	Ratings	Officers	ratings
Philippines	16010	51272	12814	14526	3196	36746
Nigeria			628	721		
China	9905	27485	34928	66958	-25023	-39472
Portugal	188	787	816	934	-628	-147
Mozambique			91	102		

Source: Institute for Employment Research, 1990

3.4 LINK WITH RAIL TRANSPORT

Africa South of the Sahara points out that Mozambique derives much of its income from charges on goods carried between Zimbabwe, Zambia, Malawi, Swaziland and South Africa and its ports. Railways play a dominant part in this middle-man economy. The main lines are: from Maputo, the Maputo-Ressano Garcia line to the

South African border, the Maputo-Goba line to the Swaziland border, and the Maputo-Chicualacuala line to the Zimbabwe border in the south; from Beira, the Beira-Mutate line to the Zimbabwe border, the Trans-Zambezia line to the Malawi border, and the Tete line. In the north the main route is the Nacala-Malawi line, with a branch-line to Lichinga. All these lines are intended primarily to export the products of land-locked countries, and secondarily to transport Mozambican goods.

CHAPTER IV

SHIPYARDS FACILITIES FOR SHIP REPAIR

4.1 GENERAL

Drewery Shipping point out that the great majority of ship repair and maintenance work is performed following classifications guidelines.

Although dry-docking plays an essential part in shiprepair, the great majority of repair and maintenance work is normally performed while the ship is afloat. This work will to a limited extent, be undertaken by the ship's staff, although with the diminution of ship's crews both in numbers and skill base this will be done less in the future within most work being undertaken by the shipyard or by sub-contractors. Based on new developments it is now common for much of this afloat work to be undertaken at the same time as dry-docking and to fit in with the class survey cycle.

Ship repair works are needed as an integral part of ship operations. The required repair work can be caused by accidents, malfunctions, ages of machinery, classification rulings, etc.

The repair works, therefore, cover a very wide engineering field and shiprepairs demand a range of facilities. These include:

- Dry-dock/Floating dock/Synchrolift/slip suitable for under water repairs
- Quays or piers suitable for afloat repairs
- Shops and areas for performing various kinds of work, such as :
 - Steel marking, cutting and forming
 - Steel assembly, surface preparation and coating
 - Pipe work
 - Sheet metal

- Machinery repairs
- Electrical repairs
- Forging and casting
- Joinery.
- Cranes and mobile machinery for repair and maintenance
- Storage space
- Administrative block.

4.2 FACILITIES NORMALLY PROVIDED FOR SHIP REPAIR & MAINTENANCE

Drewery Shipping provides a wide range of information on the ship repairing and the closely related shipbuilding and shipconversion industries. The direct economic advantage which is so important in creating shipbuilding strategic advantage is also important in attracting operational ships.

In addition to the provision of basic and modern shiprepairs, the modern depends on the provision of a wide range of services. The range and sophistication of the services required will to some extent depend upon the type of ship. Passenger vessels, for instance, require an extensive range of specialist contractors in hotel servicing and safety. A repair shipyard, therefore, is itself dependent upon a hinterland of specialists and to be successful it must have access to wide, unimpeded, international back-up.

Despite the fact that much of the important work performed in shiprepair is done under the supervision of classification societies, quality can vary from shipyard to shipyard or from contract to contract. Low quality may result from a determination on the part of a shipowner to cut repairs to the bone or from a failure by the shipyard to fully complete contracted items, which is likely to bring disputes among contractors, or just from plain bad workmanship or poor supervision.

A shipyard must also provide services such as water supply, power and light, compressed air, moorings, firefighting and medical arrangements, safety

organisation, and crew facilities for the ship whilst it is demobilised and being repaired. In addition to hull and machinery repairs, a ship will need to call upon many auxiliary skills or services some of which may be supplied directly by the shipyard, subcontracted by the shipyard or organised directly by the shipowner.

Shiprepair yards are expected to undertake a wide variety of work, often by day or night and, to be viable, work must be normally performed on a number of ships simultaneously. In answer to the needs of bigger ships requiring quicker turnarounds many yards have been modified in design and layout. The extent of efficiency with which they are used, will largely dictate utilisation factors and profitability.

The core facility of a shipyard is its dry-docking facilities. Although, on average, most cargo ships may be expected to spend only a small number of days every two to three years in dry-dock, on becoming older, ships require more underwater work and extensive hull replating might prove necessary, which can only be accomplished in dry-dock. Additionally, much work on machinery, hull and accommodation will require to be done afloat in shiprepair yards (Drewery Consultants 1994).

The shipyards in Mozambique are under three different Ministries. The Ministry of Transport & Communications, the Ministry of Industry & Energy and the Ministry of Food & Agriculture. Its worth mentioning that quite recently, according to official reports, the Secretary of State for Fisheries, which used to be a separate Ministry, has been absorbed/placed under the Ministry of Food & Agriculture.

4.3 DESCRIPTION OF EXISTING SHIPYARDS IN MOZAMBIQUE

There are three main shipyards and one more under construction in the country.

Three main shipyards are analysed by Jopela from view points of ability and prospect of the shipyards, (Jopela,1995).

- ENAMA- a float dock on the south side of Maputo Bay.
- EMARNA- a graving dock on the North side of Maputo Bay.
- ENABE- a graving dock in the Central region Beira town.
- The new graving dock at the North region of Quelimane town. This has yet to commence business.

4.3.1 ESTALEIROS NAVAIS DE MAPUTO (EMANA)

EMANA is under the Ministry of Food and Agriculture.

The shipyard comprises a floating dock capable of docking vessels up to 115 x 18 x 6.5 meters or 4,200 dwt. It is engaged in ship maintenance, ship repairs and general steel works, with a total workforce of about 170 employees. In addition to the floating workshop, there is a supporting shore workshop located in Maputo City.

The floating workshop and the supporting one are well equipped so that a means of production exists which allows ship construction activity and heavy metal work to be carried out. However, there are some limitations regarding space and handling equipment. The utilisation of the outfitting quay is limited.

The level of organisation is considered adequate. This shipyard offers good working conditions in terms of modern equipment in both workshops.

An analysis of EMANA's objective is to provide global services, closer relationships with customers and improvement of responsiveness to all services in naval repairs. Jopela, (1995) provides the following analysis:

a) Strengths of EMANA

- Good level of organisation.
- Good educational background of the staff
- Reasonable commercial activity.
- Effective marketing and good advertising through the local media.

b) Weaknesses of EMANA

- Ineffective organisational structure.
- Low motivation of the management and employees.
- Underutilization of potential available.
- Need for better handling equipment.
- Low level of innovation.

- The floating workshop is short of space
- Increasing operational costs with repairs and maintenance of the 15 year old floating dock.

c) Opportunities of EMANA

- Developed joint venture with Lisnave International, Portugal- a very experienced and well known group in shipbuilding, repairs and conversions all over the world.
- Imported new technology
- Quick development of new building and natural trend to expand.

d) Threats of EMANA

- Strong competition from other shipyards in the country.
- Possible new competitors.

The lack of infrastructure and the skilled personnel to carry out the work at the EMANA shipyard is a very difficult problem at the moment and is common to all the different shipyards along Mozambican coast.

It is important to mention that most of the contracted technical manpower are engineers with an insufficient background in ship structure work and marine engineering. This manpower is therefore assigned to a senior engineer, and this one, usually is non-specialised engineer, clearly without teaching skills. A consequence is that difficulties exchanging ideas occur during the job.

Some shipowners have a tendency to go for better shipyards in neighbouring countries of Mozambique, such as Durban, Mombassa and Diego Suarez, where dry-docking work is performed very fast and efficiently.

4.3.2 ESTALEIROS NAVAIS DA BEIRA (ENABE)

ENABE is a state enterprise under the Ministry of Industry and Energy. It was founded in 1978 as a result of the unification of different enterprises and institutions. This shipyard is operating with a total workforce of about 200 employees. It has a principal activity of providing assistance in maintenance and repairs to craft involved

in cabotage, dredging operations, tug services, barges and fishing boats operating in the coastal waters.

The yard has a graving dock capable of serving vessels up to 110 x 17 x 6.5 meters and an outfitting quay of 200 meters. The shipyard's equipment is obsolete and there is a need for its replacement, especially in the plate workshop, with new technically advanced equipment.

a) Strengths of ENABE

- The shipyard is located at a strategic position in the central region in the country.
- Equipped with powerful pumps capable of reducing the dock operation time (the pumps can empty the dock in less than two hours).
- An outfitting quay of 200 meters

b) Weaknesses of ENABE

- No crane facilities along the outfitting quay
- The draft at lower tide is limited to 2.5 meters
- Old and obsolete equipment in most of the workshops
- Underutilization of available potential
- Low level of innovation
- Ineffective organisational structure.

c) Opportunities of ENABE

- Continuous growth of trade in the Beira Corridor that may increase the number of ships calling at the port.
- Proposed establishment of new agriculture and fisheries industries.

d) Threats of ENABE

- Explosive internal environment caused by a high turnover of people in key positions
- Quick proliferation of small workshops in the local repair market.

4.3.3. ESTALEIRO DE MANUTENÇÃO E REPARAÇÃO NAVAL (EMARNA)

EMARNA is under the Ministry of Transport and Communications. It has a total workforce of about 300 employees. The yard is technically equipped and capable of docking vessels up to 2600 dwt in a graving dock of 80 x 13.5 x 3.6 meters. In addition a slipway capable of a support weight of 80 tons.

The existing means of production allows the shipyard to assist cargo vessels, dredgers, tugs, fishing vessels, trawlers, and other national and foreigner vessels calling at Maputo port. In addition to these, the yard provides assistance to pleasure boats and national naval vessels. The construction of navigational aids e.g. buoys, and similar devices is part of the yard's activities. The yard is also outfitted with a large range of manoeuvring and auxiliary equipment for the hull repair and treatment.

EMARNA has experienced personnel at executive level but still has a shortage of assistance for the execution of high skilled work especially in shipbuilding projects.

The organisation is capable of meeting the quality standards required by clients and classification societies.

a) Strength of EMARNA

- Acceptable technology and reasonable organisation in technical and production areas.
- The internal organisation is compatible with the medium level organisation of the country
- The company offers better prices than both internal and external competitors.
- Qualified workforce especially at the executive level
- The quality of services is adequate to the needs of the market for which the shipyards is operating
- Location in a good Geo.-economical area.

b) Weaknesses of EMARNA

- The outfitting quay has no crane facilities (using as an alternative mobile cranes).
- Underutilisation of available potential
- The average academic level of employees is low. The majority have only basic training, making it difficult to introduce new working methods.

- Total absence of advertisement/marketing i.e. the media is not being used.
- Problems of integration for some employees especially for those who were not directly hired by the shipyard.
- Ineffective organisational structure
- Low productivity usually registered in orders coming after a lean period.
- Low level of innovation.

c) Threats of EMARNA

- The internal market is to some extent confined to fishing companies with a low growth expectation due to restrictions imposed by the secretary of state for fisheries in the issuing of fishing licences.
- Keen competition from other shipyards and from very recent established metal workshops.

d) Opportunities of EMARNA

- Good perspectives of diversification into services that the competitors are not so much involved.
- Good perspectives of growth
- Privatisation of the company is under way. So there is high hope that the future shareholders will adopt practical methods to overcome part of the current difficulties e.g. in securing commercial contracts.

4.3.4 ASSESSMENT OF THE THREE SHIPYARDS

Assessing the three shipyards, the common opportunities, weaknesses and threats are:

a) Strength of Mozambican shipyards

- EMANA and ENABE have 5000 dwt class docking systems. Their facilities can be provided for an international market.
- The three shipyards are located at an intermediate trade between the inland mining/agriculture resources and overseas.

b) Weaknesses of Mozambican shipyards

- Absence of energy management system, which could be solved by portable or unattended emergency generators.
- No compliance with the latest environmental requirements for example reception facilities.
- Inefficient organisational structure.

c) Opportunities to Mozambican shipyards

- Increasing possibilities for shipyards to correct their own weaknesses.
- There is much room for innovation and diversification.

d) Threats

- The market fluctuation with the rising inflation at unpredictable levels, does not allow easy implementation of strategic planning.
- Possible new competitors

4.4 OTHER SHIPYARDS RELATED INDUSTRIES

The national markets for spare parts/materials do not have the capability to compete in terms of quality, delivery time and prices. National shipyards usually import from external markets and sometimes from neighbouring countries, mainly from South Africa.

According to the newly adopted free enterprise policy, however there is not been enough incentive to force the shipyards to place direct orders with local import/export companies to ensure the quick delivery of materials and spare parts. The shipyards always face the shortage of the materials mainly from the following suppliers:

- Steel factories and foundries
- Industrial gas factories(oxygen, acetylene)
- Welding electrodes suppliers
- Paint factories
- Rubber factories

CHAPTER V

ISM CODE WITH REGARDS TO SHIP'S MAINTENANCE

5.1 INTRODUCTION

The Internal Safety Management (ISM) Code as SOLAS 74 chapter IX comes into effect first in July 1998. This IMO regulation will directly affect MET and shipping industries and it is therefore essential that the code is understood, particularly those sections which refers to Ship Maintenance.

Therefore it is essential to understand the code related to ship's maintenance.

Guidelines on the Implementation of the ISM Code, defines the code as a written guide giving specific examples and formats for drafting safety management manuals within an organisation. Procedures and drafts should be provided to any institution dealing with the education and training of seafarers in way that trainees will get the opportunity to appreciate different strategies from different organisations on the implementing the ISM code.

The rules and procedures of the ISM Code are not to interfere with or constrain individual corporate procedures and formats. Most of examples are directed for general cargo ships since ships like oil tankers and chemical tankers normally employ their own cargo handling procedures and steps for preventing marine pollution which may vary from ship to ship; therefore, it is necessary to consider the contents of this chapter according to the types of ship which the company manages.

Accordingly, the shipping company should establish the procedures by which the ship is maintained in conformity with the provisions of the relevant rules and regulations and also with any additional requirements which may be established by itself. Therefore the personnel in charge of implementation of the maintenance of ships should report the results of implementation and record them based on the plans. Non-

conformity which has been detected by inspection or during accidents, should be investigated, reported, analysed, and corrective actions should be adopted. At the same time, measures to prevent recurrence should be adopted. The company should establish and manage these services so that they are functionally effective.

5.2. SAFETY MANAGEMENT

Ship management is concerned with managing services related to ship operations, inspections and maintenance, and crew matters. On board ship such machinery management tasks are to be assigned to the chief engineer.

Among ship management services, those specifically related to the safe operations of ships are as follows:

- Employment and manning of crew members (employment, crew transfers, arrangement of wages, training, management of crew members through the service regulations)
- Technical management (operations and maintenance of the ship by competent personnel, arranging statutory surveys, classification surveys, and inspections, dry docking, repairs, conversions and maintenance at the request of the owner, supervising and arranging consumable, spare parts and lubricating oils, and arranging specialists when necessary)
- Matters related to voyage management (including the handling of marine casualties and cargo damage)
- Matters related to preventing marine pollution.

5.3 MAINTENANCE PROCEDURES

There are several procedures on ship maintenance. Procedures are set up as a way to have an organised working environment. When a maintenance task is to be undertaken, the methods and rules previously set by the company should be followed. This procedure is advantageous since any problem which may come out because of incompetence or misunderstanding of the rules can be settled easily.

Appointment of personnel responsible for maintenance on shore

Appointment of personnel for the cargo maintenance management (Maintenance Managers) to serve on both company and on board ships. It should be personnel of a rank equivalent to the superintendent engineer or manager of the ship maintenance division, with the perquisite that they possess adequate knowledge, technical skill and experience in maintaining ships and in maintenance procedures.

Maintenance and management of relevant certificates, survey reports, drawing and books

For the maintenance of ships the certificates, survey reports, drawings, instruction manual, etc., should be retained and maintained on board the relevant ships, but a set of copies of all the items mentioned above should be provided to the personnel in charge of maintenance on shore also. A list of all the certificates, survey reports, drawings, instruction manuals, etc., retained by the maintenance management personnel on the shore should be included in the procedures for maintenance management.

Certificates and other documents required to be provided to the maintenance personnel on shore are given below:

- Certificate of Registry
- Survey Certificates, Survey Books
- Certification of the Prevention of Marine Pollution, Survey Book for the Prevention of Marine Pollution.
- Classification Certificate, International Certificate for the Prevention of Marine Pollution, etc.
- Radio Station Certificate (Radio Station Survey Book, including outstaying Recommendations)
- Finished Plan
- Instruction Manuals of important Machinery and equipment.
- Survey reports from the Administration, classification Societies, etc.,
- Inspection reports from the Master and various personnel in charge of maintenance
- Report of analysis of oil properties

Normally certificates and other items mentioned above should be classified by ship and common items should be identified and managed

Implementation of continuous maintenance

The shipping company should establish implementation procedures which include continuous maintenance and implementation plans, certificates, records, and reports.

Plans and implementation

A maintenance plan which includes service, inspection, period of inspection, assessment standards, and personnel in charge of implementation should be established. The procedure should include dry-docking preparations, preparation of repair specifications, etc.

Certificates, records and reports

The maintenance services implemented according to prescribed procedures should be verified and recorded by the prescribed personnel and reported to the personnel in charge of maintenance. The company should select the dry-docking yard, prepare the dry-docking indents, and preferably prepare procedures prescribing responsibilities and authority during dry-docking in case of dry-docking repair including afloat repairs and inspections, in addition to the implementation plans for maintenance mentioned above.

Specification of Important Maintenance Services

The shipping company should establish procedures in the safety management system to identify equipment and technical systems sudden operational failure of which may result in hazardous situations. The safety management system should provide for specific measures aimed at promoting the reliability of such equipment or systems.

These management procedures should include the items mentioned below:

- Simple explanations on surveys, inspections and trials;
- Explanations on maintenance service methods and periods;
- Maintenance of spare machinery equipment and spare system;
- Periodical inspections.

Maintenance services implemented according to prescribed procedures should be inspected by prescribed personnel. Maintenance records should be retained and maintained on board the relevant ship.

These records or copies of the important records should collate the records, and essential report items for the review and improvements of the system to the designated person together with the status of implementation maintenance.

These maintenance records should also include records of dry-docking repairs and other repairs, and survey records of the Administration and Classification Society.

CHAPTER VI

TYPES OF MACHINERY MAINTENANCE

6.1 GENERAL

The definition of main maintenance procedures has proved to be problematic. This has chiefly been because of the vagueness of different areas of maintenance which makes them difficult to categorise. In this paper three subdivision of main are determined: Planned, Preventive and Corrective Maintenance.

The subdivision of the main types of maintenance (**Planned Maintenance, Preventive Maintenance and Corrective Maintenance**) is made according to the objectives and procedures to be met or undergone when performing any maintenance task. The most important features of a basic organisational structure is that it facilitates planning and performing. This can be hampered however by such things as environmental conditions, and human failure. Plans, therefore, may not always meet their expectations. The most serious impediment to maintenance planning is the disregard of shipowners lack seafaring knowledge, and over emphasise financial stringency at the expense of proper maintenance.

6.2 PLANNED MAINTENANCE

Planned maintenance is one of the most important aspects of the machinery maintenance program. Whenever a plan is to be done a number of questions have to be raised by all parties involved in the operation of the ship. Normally there is a concern about the financial resources, policy and human resources adopted by the shipping company and sometimes the classification society concerned.

Planned maintenance consists of inspection, watches, hourly, daily, weekly and yearly inspections, and the appropriate renewal of machinery.

These should all be planned according to the characteristics of the machinery.

Well performed planned maintenance reduces equipment failure and the operational costs of the ship, risks to crew and cargo, and damage to the marine environment.

The small financial input of planned maintenance can provide substantial returns.

On the need for an effective planned machinery maintenance Drewery Consultants highlights 4 key areas that need to be attended to when it is planned, which are as follows:

- A complete knowledge of all items to be covered;
- The priority to be assigned to each item;
- The extent of maintenance required and how long it will take in each case, together with the facilities, materials, manpower, skills and spare parts replacement required;
- How often, by calendar, running time or feed back information must maintenance be undertaken and how can work be combined and accomplished with minimal adverse affect on the ship's operation, Drewery Consultants 1994.

Planned maintenance therefore is really a chain of factors, a sequence of discrete operations and activities, which must be tackled together as a whole to form an integrated and complimentary programme.

6.2.1 MAINTENANCE PLANNING SYSTEM

A planned system is expected to be a tool for an organised procedure of the machinery maintenance system. However there is a number of factors which unavoidably happen during the life of a ship which cannot be planned for..

One of the advantages of a planned system is the most of the tasks which are very expensive can be highlighted on the list of repairs and maintenance and thus it will

be possible for the people concerned with planning issues to meet and discuss the budgetary procedures.

A further advantage is that the tendency to overlook certain items of repair and maintenance, can be avoided with a planned system.

A popular maintenance planning system is the basis of one of the IMO Model courses 2.01. Organisations, companies and institutions in the developing countries related to shipping industry can benefit by understanding this IMO Model course and the ISM code. The system is based on TSAR (1990), a Norwegian term meaning hour registration, systematic maintenance, filing and spare parts system, shown in Fig. 6.1. Filing is related to an organised way of keeping drawings and instructions which need to be followed for maintenance purposes and the labelling of spare parts according the specified code on each ship owned by the shipping company.

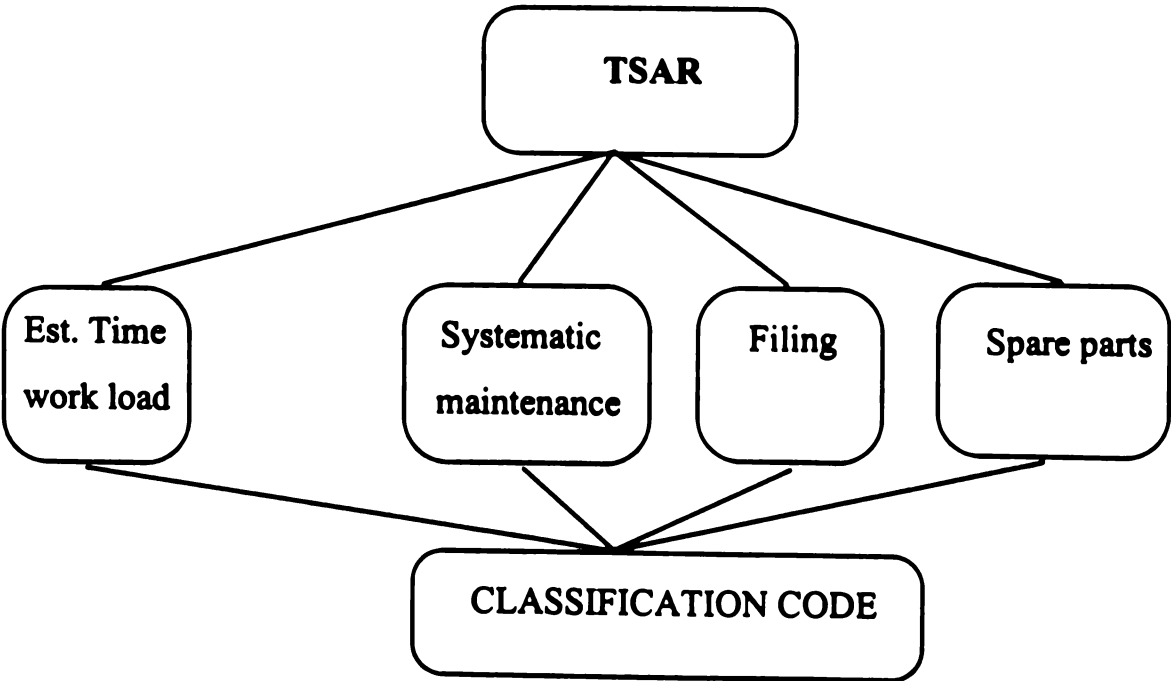


Fig 6.1 Maintenance Planning System (Source: IMO Model Course 2.01)

The proposed system can normally be operated on a data base, depending on the complexity of the information and communication between decision-makers.

It includes a number of items which should be grouped within a system. The combination of the items of the system should reflect a selection of the basic elements necessary for the performance of maintenance. On this base, technical information from the equipment makers and instruction material, scheduling procedures, maintenance records, feed back and cycle of operations have to be tackled as a whole, and any maintenance task should be performed according the information contained in the items. Definitions of the items which constitute the system are given in the following:

Technical information

All relevant technical information and registrations for each unit of equipment requiring maintenance should be contained in a maintenance book. The book is edited according to the classification code system and contains forms like the one shown in Fig. 6.2. with information of a Starting Air Compressor on maker, type, serial number, capacity, etc., as it is required for the precise identification of a unit. The forms also give a listing of the various types of maintenance job, with estimated intervals and references to instruction materials.

Technical information should be contained in a program book. In this case all components are listed together with a group number for identification. Each item has a brief description in a maintenance record book where a more detailed account of the work required will be listed. The programme book will also include intervals for maintenance and a data and follow up scheme shown in Appendix 1.

Instruction material

Instruction material from manufacturers and yard are filed systematically according the classification code system for easy retrieval. References are made to the relevant

parts of the material. Description of spare parts and tools to be used for the various maintenance jobs should be part of this material.

Scheduling Procedures

Scheduling procedures reflect the way in which the organisation or shipping company organises its maintenance system. It varies with type of maintenance system designed by the shipping company and there may have maintenance books, jobcards or planning boards.

For each job specified in the maintenance book a jobcard is made and displayed in a rack system mounted on a bulkhead.

The jobcards may call for different types of jobs, such as condition monitoring, visual inspections, changing of parts, calibrations and megger testing.

The jobcard shown in Appendix 2 may have different colours to signify the type of work, responsibility, priority, work to be done in harbour, classification, certification, etc.

A special display board like Fig. 6.3. is arranged for the scheduling of jobs which depend on machinery running hours

Fig 6.3 shows that the auxiliary engine No 1 has been running for 300 hours and such is indicated by a movable indicator for running hours, which really is an automatic device installed with chronometer, and linked to the engine.

Routines No1 and No 2 are completed by the end of 700 running hours and at that time any prescribed maintenance will be done.

Routines No 3 and No 4 will be reached after 800 and 900 running hours respectively. Other prescribed kind of maintenance should be done by the end of those routines.

All kind of maintenance being performed by the end of any routine will be done according to the specifications contained in the instruction material and maintenance records should be done. Feed back information should be provided to shore side.

Description of unit				Code no.	
STARTING AIR COMPRESSOR				731.01	
Manufacturer, Type, Data, Specifications, Production no. .1 Compressor Man.: Sperre Type: HV1/85 Capacity: 23m ³ /h, 30 kp/cm ² Ser. No.: 1: 4890,2 .2 Motor: Man.: NEBB Type: QUF-132-s-2a Capacity: 8.0 kw Rpm.: 1170 Ser. no.: 1:3340833,2 Ball bearings: 6308Z/6307Z .3 Starter: Man.: Sperre Type: Ser. no.:					
Job no.	Description of Work	Instruction reference	Interval (Mth.)	No.of men (M)	No. Of man-hours (MxH)
A	Jobcard no. 524 Clean air coolers and air filters. Change oil, lubricate bearing on electric motor, take meggertest, clean if necessary.	731.01 Page 10	6	2	4
B	Jobcard no. 525	Page 13	12	1	6
C	Jobcard no. 526 Classification survey	Page 15	48	1	46

Fig. 6.2 Technical Information Form (Source: IMO Model Course 2.01)

The planning of maintenance is carried into effective operation on the special planning cards which are kept in a case divided into two sections of twelve months, plus two years using the programme book to obtain the intervals between overhaul.

Maintenance records

Maintenance records are normally kept on the forms in the maintenance book. Thus, every unit form carries the maintenance history of the unit. Only exceptional situations are described, otherwise just the job number and date are entered.

The amount of reporting from ship to shore varies according to company policy.

Feed back information

The aims of reporting procedure may be stated briefly as :

- To provide operation and control data for the office
- To provide information to ship staff of the past maintenance history of particular pieces of equipment
- To provide a means of continuously updating schedules in the light of experience.

Cycle of operations

The operations of system will depend on the strategy of the company. The maintenance philosophy of companies will be different all over the world. The total management system must therefore be adjusted to the shipowner's organisation and the ship.

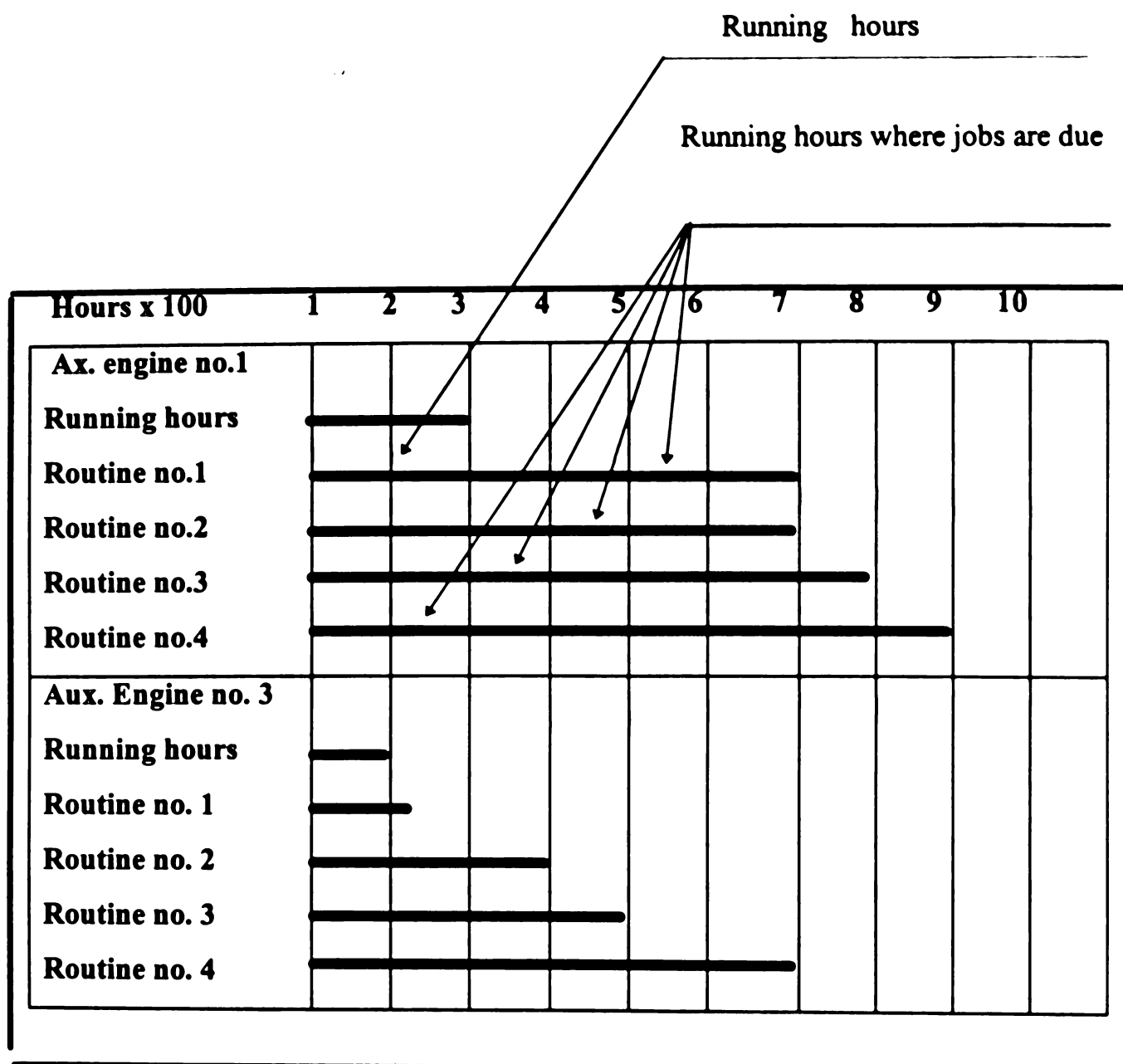


fig. 6.3. Auxiliary Engine Planning Board (IMO Model Course 2.01)

6.3 PREVENTIVE MAINTENANCE

Preventive maintenance is generally defined as a machinery maintenance programme focused on the repair or replacement of parts to avoid any operational failure.

Mostly based upon visual or remote sensing monitoring of the signs of deterioration of equipment, preventive maintenance should be concentrated on which equipment items have to be included within the programme. The degree of preventive maintenance is therefore a part of the maintenance optimisation program.

The following things should be considered when a new preventive maintenance programme is planned:

- Preventive maintenance tasks will increase maintenance costs when first initiated, until the beneficial effect of the preventive maintenance task has time to take effect;
- A preventive maintenance task may permanently increase costs;
- At the start of the preventive maintenance programme, both design and performance of the programme must be selected(Al- Shehely, 1994).

6.3.1. MANAGEMENT OF A PREVENTIVE MAINTENANCE PROGRAMME

Bernard argues that the management of the preventive maintenance should ensure the assignment of the most competent staff to design the system and then go on to consider the most critical equipment such as propulsion plant, power plant, controlling devices, and schedules, written instructions and finally implementing task according to the manpower available.

6.4 CORRECTIVE MAINTENANCE

Corrective maintenance is generally defined as maintenance which is carried out when any equipment or piece of it fails. There is a tendency to call it simply "repair." Normally before any equipment fails there will be a sign of imminent break down, through information obtained either through visual means or electronically controlled monitoring system. In corrective maintenance both planned and unplanned tasks are likely to happen, and the flexibility of the staff concerned is once again emphasised.

Rothamel divides corrective maintenance in the following way:

Emergency work, which is considered as high priority job, mostly including parts of equipment which are vital for the operation of the machinery as a whole. This is usually the one that can be classified as the unplanned corrective maintenance.

Removed parts, can be included either on the list of high priority or lower priority even it seems that they belong to the lower one.

An example of lower-order priority equipment seeking corrective maintenance on board are dismantled fuel injection valves, which normally double the spare parts allowable in the engine room.

Deferred work will have to be entered in a planned system and the repair schedule is expected to meet the availability of the staff in numbers and time. Including all broken equipment.

CHAPTER VII

ACADEMIC PROGRAM FOR MARINE ENGINEERS

7.1 INTRODUCTION

In the previous section reasons for poor machinery maintenance were considered and it was noted that a significant cause of this was shipowners negligence and lack of seafarers knowledge.

This chapter examines seafarers' training to increase their knowledge and skills in Machinery Maintenance. This is part of the academic programme for marine engineers at the Nautical School of Mozambique.

Seafarers now have to deal with the highly sophisticated equipment being installed on board ships, due to increasing marine technology. These also need to work in accordance with the relevant rules of the international maritime community, mostly on the prevention of marine accidents and for good ship maintenance. Consequently there is a need for well trained seafarers.

Competency in marine engineering sciences is linked to a good background and skills of engineering. The engineering stream is now more inclined to management side, where recently developed computer software plays a relevant role. The engineer on board need to operate such software, performing tasks such as sending data to the shore side, monitoring computer systems, checking and ordering of spare parts, and also being able to serve as staff on the shore side. The program marine engineers need to follow is based on IMO Model Course 7.02 guidelines.

7.2 ESCOLA NAUTICA DE MOZAMBIQUE

Escola Nautica de Moçambique (ENM) is an institution under the Ministry of Transport and Communications . It was founded in 1977 , initially directed to the

training of seafarers dealing with coastal navigation. Is located in Maputo, the Mozambican capital city.

The Nautical School includes four Departments: Navigation, Marine Engineering and Radio Electronics Engineering, as well as the Department of general subjects . The focus of this paper is on engineering training.

ENM has been working on the basis of “sandwich” system. The engineering students are admitted to Nautical School as graduates from the high school and have to go to sea for 6 months followed by four academic semesters at college. From there the students are admitted on board ship for one year training, after which they get award of practican engineer officer.

It is on the level of 2nd engineer where the author believes that improvements should be done, because clearly most of the officers serving on board ships are at least on the level of the practican/third engineer. According to STCW 1978 Convention these officers can apply for the second and chief engineer courses.

7.3 COURSE FOR 2ND AND CHIEF ENGINEER

7.3.1 ENTRY STANDARDS

As a minimum, trainees must have reached the standards for certification as engineer officer in charge of a watch on a seagoing ship powered by main propulsion machinery of 750 kW propulsion or more, as set out in regulation III / 4 of STCW 1978 as IMO Model course 7.04 (Engineer officer in charge of a watch). Some trainees may have satisfied the STCW certification requirements without having completed all of the work specified in IMO Model course 7.04. In such cases it may be useful to use material extracted from Course 7.04 to enable trainees to reach the entry standard assumed for this course. Appropriate modules are recommended under “Entry Standards” in cases where this could apply.

According to IMO Model course 7.02, chief and second engineer officer is intended to be integrated into the total teaching scheme for that course.

Before implementation, the instructor should read and take note of the advise contained in the course overview and the booklet entitled “Guidance on the implementation of IMO Model courses”, which is included as an attachment to the course.

The detailed teaching syllabus has been written in learning -objective format in which the objective describes what the trainee must do to demonstrate that knowledge has been transferred.

All objectives are understood to be prefixed by the words “ The expected learning outcome is that the trainee”,.

In preparing a teaching scheme and lesson plans, the instructor is free to use any teaching method or combination of methods since this is part of a mandatory qualification under the International Convention on Standards of training, Certification and Watchkeeping for Seafarers, 1978 (Now amended to STCW 1995), it is essential that trainees attain all objectives set out in the syllabus (see Appendix 3).

Table 7.1 shows the Course Outline with the lecturing time on each Model course as the subject Modules. The total lecture time is reached at 1022 hours. The implementation of the course is discussed in chapter 7.4.

7.3.2 COURSE EVALUATION

The responses expected of trainees in this course should reflect the fact that they are training to assume overall responsibility for the safe running of a ship's machinery and services, and this has far-reaching implications on the safety of passengers, crew and cargo.

To make monitoring possible, IMO recommends regular assessment of trainees. In many cases the assessment can be based on the marks given to trainees 'course work' providing a proper record of it is kept. This can be supplemented by occasional short test papers. These assessments are additional to any examination required for the

purposes of certification. The form and timing of examinations for the issue of certificates is a matter for the administration.

Table 7.1 Course Outline

		Hours	
Subject Module		Lect.	Laborat.
1	Thermodynamics and Heat Transmission	52	5
2	Mechanics and Hydromechanics	68	18
3	Operational Principles of Diesel Installations	114	
4	Operation and Maintenance of Machinery	60	
5	Physical and Chemical Properties of Fuels and Lubricants	33	
6	Technology of Materials	94	
7	Chemistry and Physics of Fire and Extinguishing Agents	28,5	7,5
8	Marine Electrotech., Electronics and Electrical Equipment	146	85
9	Fundamentals of Automation, Instr. and Control Systems	65	6
10	Naval Architecture and Ship Construction	123	
11	Maritime Law, Agreements and Conventions	36	
12	Personnel Management, Organisation and Training	31	
13	Medical Emergency- First Aid	12,25	7,75
14	Life Saving Appliances	11,75	18,25
Subtotals		874,50	147,00
Total		1022	

Adequate time should be allowed at the end of the course for revision and review of the course content. A minimum period of two weeks would seem reasonable. This period and the time occupied by examinations would be additional to the times shown in the syllabuses.

It may be decided to hold a more formal evaluation, similar to that required by the administration for certification, during the course. It must take place after sufficient work has been covered to make it worthwhile, but early enough for trainees who perform badly to rectify their shortcomings before the end of the course.

7.4 ENGINEERING COURSE PROJECT

7.4.1 INTRODUCTION

As a way of letting the ENM know of the content of this work, there should be one copy of this work available to the school, which will allow any interested staff member to ask questions or raise ideas concerned.

Further discussions of the proposed syllabus within ENM may be achieved, and as the school is under the Ministry of Transport it is likely that discussion will broaden to this sector and its further approval may be achieved. The announcement of the course should be made in way to attract trainees either through national media or other related sources. At the same time the staff in charge of the acquisition of an engineroom simulator and software programs should be under training. Quality assessors should be invited to the school shortly before the beginning the course in a way to allow them to recognise the curriculum.

Examinations in advanced maths, Physics and English language will play a relevant role to make sure that trainees are up-to-date on engineering knowledge.

7.4.2 STEPS FOR COURSE PROJECT

The course project contains 13 selected activities which are introduced in chronological order. This is intended to save time and to face logical doubts expected from the top management within Nautical School and the Ministry as well.

The selection is based on the fact that a reasonable number of staff should be available to make up a working team. On this, the team members sometimes should work on different issues simultaneously, and at least meet once every two days and discuss the level of progress of the project, feed back procedures and others.

Steps for introduction of the project to ENM are as follows:

- Introduction of the paper to ENM
- Discussion of the syllabus within ENM
- Discussion and approval of the paper by the Ministry of Transport
- Financing Process
- Selection of the staff
- Revising of the IMO Model courses concerned
- Upgrading of few teaching equipment
- Announcement of the Course through media
- Contract/Acquisition of an engine room simulator, new software for computer aided learning (CAL)
- Selection of trainees
- Training of staff concerned
- Quality assessment
- Final provisions and start of the course

Table 7.2 is made up of a number of activities to be performed in the implementation of the course project. The time needed for the completion of any activity (in weeks), preceding and succeeding activities are illustrated as well.

Taking job No 2 as an example, defined as 'Discussion of the syllabuses within ENM', this activity will take two weeks and must be preceded by activity No1 'Introduction of the paper to ENM'. The activity of the present example is expected to be followed by activity No3 (Discussion and approval by the Ministry).

The example above shows the common chain order in the steps for decision making between ENM and the Ministry of Transport.

The above sequence of events does not give the precise time in which the project can be finalised. The total project time duration is analysed in the final arrow diagram presented in Fig. 7.2.

Table 7.2 Project Schedule

Activity	Activ. Description	Activ. Duration (week)	Preceding Activity	Succeeding Activ.
1	Introduction of the paper to ENM	1	-----	2, 5 & 6
2	Discussion of the syllabus within ENM	2	1	3
3	Discussion and approval by the Ministry	3	2, 5 & 6	4 & 9
4	Financing Process	1	3	7
5	Selection of the staff	2	1	3
6	Revising of the IMO Model course concerned	1	1	3
7	Upgrading of few teaching equipment	2	4	8, 10 & 11
8	Announcement of the course through media	1	4, 7 & 9	12
9	Contract/Acquisition of an engineroom Simulator	3	3	8, 10 & 11
10	Selection of trainees	2	4, 7 & 9	12
11	Training of staff concerned	2	4, 7 & 9	12
12	Quality assessment	3	8, 10 & 11	13
13	Final provisions and start of the course	1	12	-----

The following is a detailed plan for the implementation of IMO model course 7.02 at the ENM. It details the implementation from initial discussions with the Ministry of Transport through the acquisition of materials and training of seafarers to the start of the course. The total time estimated for this implementation process is 15 weeks. It

should be noted that the timing is tentative and may require revision according to the constraints that may occur in Mozambique, for example bureaucratic delays may result in some activities taking much longer.

The implementation planning process is based on a system outlined by Butman in a lecture at the WMU this year, and is detailed in the figures and diagrams (Table 7.2, 7.3 and figures 7.1, 7.2). For a full understanding of the implementation process this information should be studied together.

Table 7.2 is the project schedule. It defines the 13 separate activities involved in the implementation process, indicates how long each activity should last and places each activity within the context of the overall sequence. So, for example, activity 7 is the upgrading of teaching equipment and this should take two weeks; it is preceded by activity 4 and followed by activities 8, 10 and 11.

Table 7.3 is a bar chart which details the sequence of implementation activities over the proposed 15 week period. The chart clearly identifies times of critical activity and float weeks i.e. periods when a particular activity is completed before the completion of another activity the outcome of which it depends. Float weeks occur in activities 6 (revision of IMO models) and 8 (announcement of the course).

Fig. 7.1 is a diagram which depicts the interrelationship between the different activities and their interdependence in terms of their successful completion and timing. The numbered arrows denote the different activities (which were listed in Table 7.2) and the letters denote the completion point of one activity and the start of another. So, activity arrow 3 (discussion with the ministry) leads to completion point F, which is the starting point for activities 4 and 9.

Fig 7.1 is a preliminary plan. It can be seen that the completion / start points H ((completion of the upgrading of the equipment) and point I (the successful acquisition of the simulator) coincide i.e. they happen at the same time.

Fig. 7.2 is the final proposed implementation plan. It can be seen that points I and H are merged to form the single completion point I.

It can be noted from the diagram that some of the tasks are “free standing” i.e. they take place while no other activity is going on. These are activities 1, 3, 12 and 13. Other tasks are in fixed sequence. These includes tasks 4 and 7. Others run concurrently, for example tasks 8 and 11.

The bar chart diagram allow the identification of crucial points in the implementation process. It can also show times when float times occur.

Considering different factors influencing in the calculations of the extension of tasks, it is worth mentioning the most important points of the project.

Taking one point for example:

- Point E, which represents the end point of tasks 2, 5 and 6.

The time needed for reaching the mentioned point is calculated as a sum of job 1 and the latest job within the group formed by tasks 2, 5 and 6. Therefore task 1 is designed for one week and either of the two tasks 2 or 5 will be designed for two weeks as the latest time.

Summing up, point E is expected to be completed in three weeks from the beginning of the project:

$$\begin{aligned}
 Tt_E &= \sum J_{\text{Latest}} \\
 &= J_1 + J_{2 \text{ or } 5} \\
 &= 1 + 2 \text{ weeks} \\
 &= 3 \text{ weeks.}
 \end{aligned}$$

The answer is supported by the bar chart 7.3., where tasks 2 and 5 coincide in time and task 6 presents a week float within activities. This float means that the task 6 has an early end of one week. According the same chart there are floats within tasks 7 and 8 as well.

Actually the calculation of floats within a group of tasks can be done by subtracting the time undertaken to perform the earliest task from the latest time within a chosen common point.

The Butman approaches for the calculation of total time needed for the full implementation of a project, can be presented as follows:

Total time required ---- **Tt**

Jobs ----- **J**

$$Tt = \sum J_{Latest}$$

$$Tt = [J_1+J_5+J_3+J_9+J_{10}+J_{12}+J_{13}]$$

$$= 1+2+3+3+2+3+1$$

$$= 15 \text{ weeks}$$

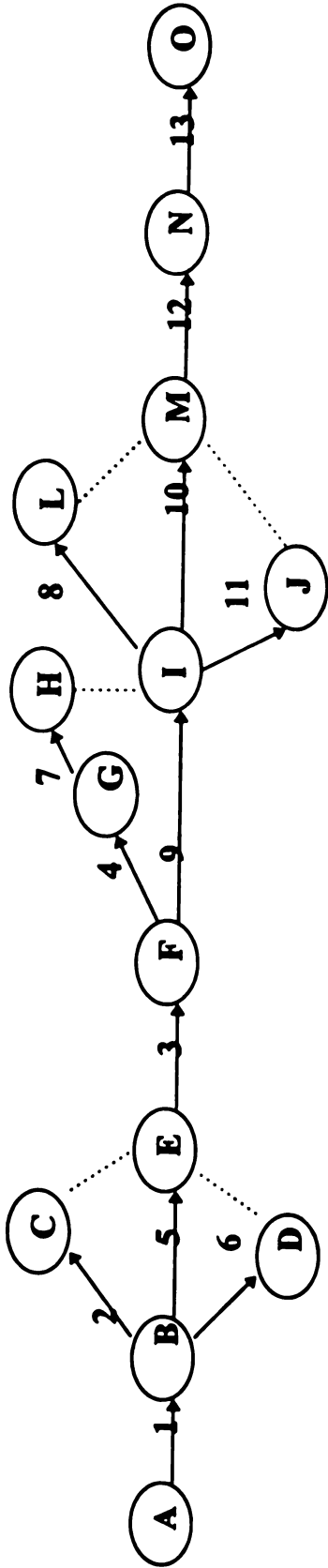


Fig. 7.1 Preliminary draft of Arrow Diagram

1, 2, 3, 4, 5, ... and 13 ---- Arrows indicating different jobs which make up the project
 A, B, C, D, and O ----- Points start/end of given jobs

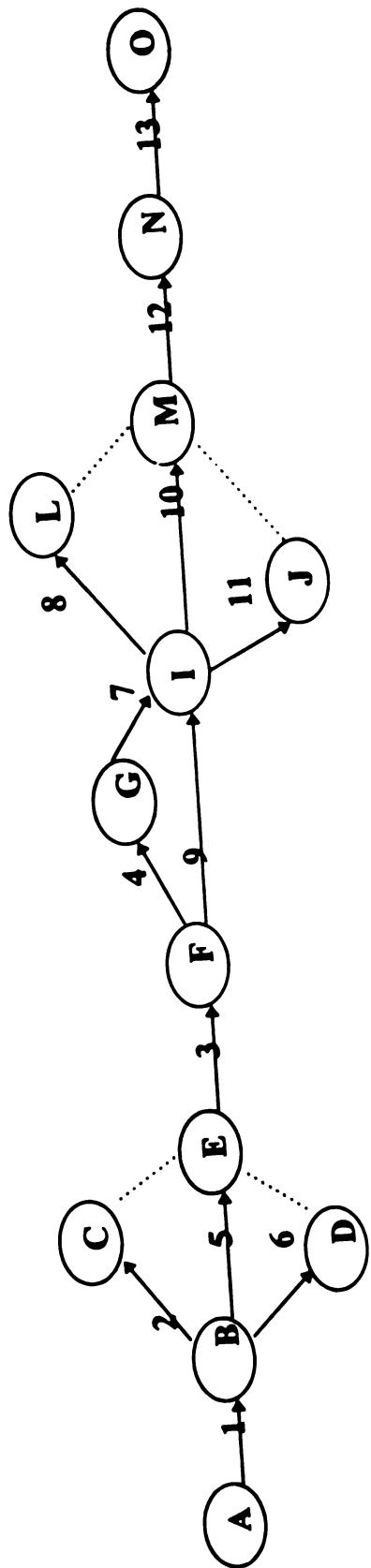


Fig. 7.2 Final Arrow Diagram
1, 2, 3, 4, 5, ... and 13 ---- Arrows indicating different jobs which make up the project
A, B, C, D, ... and O ----- Points indicating start/end of project jobs

WORKING WEEKS

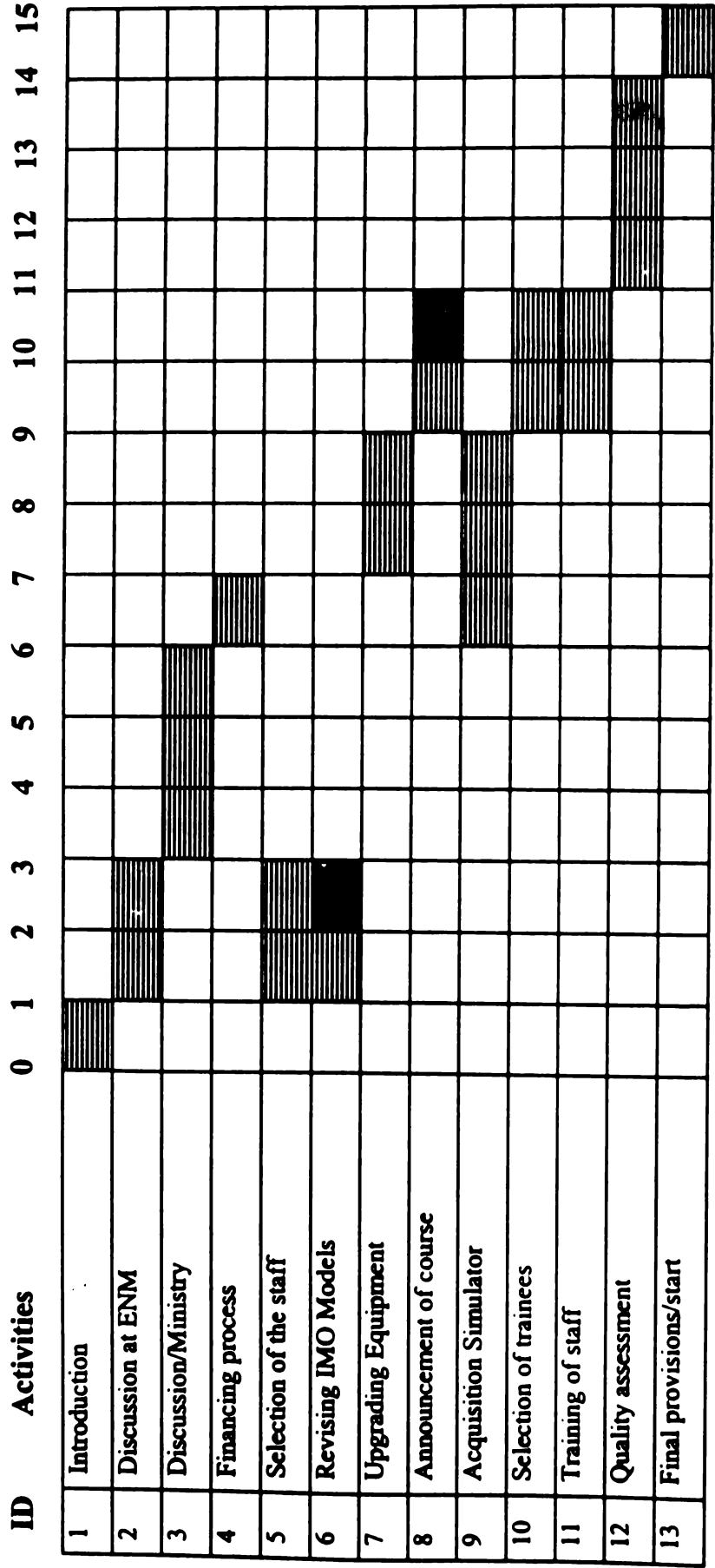


Fig. 7.3 Bar Chart Diagram



7.5. TRAINING OF EMPLOYEES

The commitment from top management of the company is most important. A statement of training policy and the designation of people responsible within the organisation, will help to ensure that the message gets through to the seafarers (and the feed-back gets back from them to management). The training should have clear objectives, which are set in relation the Company's ships and trades.

Alternative methods of training are advisable. Optimum choice for a particular company will depend upon the costs, man power, crew structures, availability of shore- based and ship board services etc.

However the training is carried out, competent and well- briefed trainers are required, with adequate resources.

The overall effectiveness of the implementation of the International Safety Management code will be marked by two extremes:

- Its minimal effect on companies which are thinking and planning ahead and implementing good company training schemes now;
- The ISM code is a challenge to managers, trainers and seafarers.

The system should include an established training plan for the employees and procedures to be implemented. The training in the system does not merely imply educating and guiding the employees in all methods and techniques of ship management, but educating and training the employees in all skills and techniques necessary for effectively implementing services and activities which affect the system, without hindrances.

The periods and methods for training the employees are generally as follows:

1. Training of new employees
2. Offer of documents before joining ship
3. On-the-job training at the working place
4. Intermediate training at the time of promotions
5. Special training with the aim of qualifying in specific skills

It is recommended that a “training curriculum” be established in ship management for the trainees.

7.5.1. PROCEDURES FOR IMPLEMENTING TRAINING

Procedures related to the implementation of training programmes should include the items below:

- Proposal, investigation, and approval procedures for basic plan and other training plans;
- Methods for implementing training programmes, supervisors and personnel in charge of implementation;
- Assessment of training results and personnel responsible for the same.

The company should have established procedures for giving knowledge and information about the ship which a new crew member is about to join. It is recommended that the procedures contain items such as are given in the examples below:

- Regulations and procedures related to the safety management manual, and documents such as particulars of the ship should be sent together with the receipt to new crew members before joining the ship. The acknowledgement receipt should be maintained and managed as a record that the crew member has read and understood the information.
- Use of check sheets for self study and maintenance records

7.5.2 CREATING A TRAINING PROGRAMME

Ship design and trading patterns

To establish the objectives of the training programme, it is first necessary to consider the design and trading patterns of the ships. This is particularly important when considering new designs and new trading patterns. The end product of training should be a competent, well motivated and efficient shipboard team.

Sources of man power

Recruitment sources and training methods may be chosen from a wide range of alternatives. The ISM advise that attitude and motivation of individuals at all levels determines the end result is important in making these choices. Personnel take a long time to train and gain experience for senior posts and in times of manpower shortage, long-term planning to develop and retain company sea staff becomes more important.

In a recent study carried out by a research team within European Union and outside, fourteen criteria to judge standards of maritime education and training were decided, but the most important were considered as the general education of entrants, language and communications skills, quality of shore-based training and quality of sea training/experience, Class NK, (1996).

These qualifications include knowledge of safety of ships and their maintenance.

CHAPTER VIII

CONCLUSION

The aim of this dissertation has been to provide information on the implementation of an academic programme of machinery maintenance for a Nautical School. Its main objective has been to design a programme appropriate to the actual conditions of the Nautical school in Mozambique.

The designing of the programme is based on international regulations and codes, especially the ISM code, IMO Model courses including the TSAR system. A thorough understanding of these systems and codes is seen as a necessary foundation for a course in education and training of marine engineers.

The programme on machinery maintenance at the school is intended to help marine engineers serving on board ships and shore side by improving their understanding of ship repair and maintenance.

As background to the preparation of a paper has provided on detailed examination in 4 main subject areas: an explanation of maintenance manners of machinery, possibility of trading with natural resources and industry, present features of three major shipyards in the country, items of ISM code related to ship machinery, IMO Module course of machinery maintenance and teaching plans for the Nautical School.

In chapter 2, the civil war during 1987 - 1990 affected obviously the output of productions of natural resources and industries, according to the statistics.

Chapters 3 and 4 analyse the features of the shipping industry and the three major shipyards.

It is argued that the shipping industry including shipyards progress beyond their present substandard condition need to emerge from the present condition, otherwise

requirements of the ISM Code will not be reached. Otherwise the shipping industry of Mozambique can not compete in the international market.

Chapters 6 and 7 introduce the IMO Model course for machinery maintenance and TSAR system for maintenance on board.

In the same chapters the implementation programmes of marine engineering subject include maintenance aspects in the Nautical school which are discussed by Butmans concept.

The engineering stream of the Nautical school and the three shipyards can adapt and implement this programme to attain up the standards of ISM code and The STCW95 convention.

The implementation of the academic machinery program will be costly for the country, but with its fulfilment there will be a number of opportunities to Mozambican seafarers seeking job any where which will a benefit for the country.

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APPENDICES

EQUIPMENT/COMPONENT	Group no.	Maint. Descr. no.	App. interval	Corr. interval	Examination programmed at month no.	Date carried out
Lubricating oil systems. (Double bottom tanks, see also hull group no. 10)	3.6.7.2					
L.O. Pipelines, valves and filters	3.6.1.1	0	48-60 mth.		k4-10	
rest,2)	3.6.2.1	1	48-60 mth.			
L.O. Bearing system tank ME	3.6.2.2	1	48-60 mth			
L.O. Renovation tank	3.6.2.3	1	6-12 mth			
L.O. Camshaft system tank ME	3.6.2.4	1	48-60 mth			
L.O. Drain tanks						

Appendix 1 Technical Information and Planning Form (Source: IMO Model Course 2.01)
 Related to section 6.2.1 (maintenance planning system)

Appendix 2

<u>731.01.1 B</u>	12 Mth.
Starting air compressor	
Clean, overhaul, etc.	
Clean and overhaul all valves.	
Instr. Ref. 731.01 Page 13	
CARD NO. 525	TSAR
MH= 6 M=1	NSFI
	©

- GREEN: MAINTENANCE DEPENDING ON M.E. STOP**
- CLEAR: MAINTENANCE ENGINE DEPARTMENT**
- YELLOW: MAINTENANCE DECK DEPARTMENT**
- BLUE: MAINTENANCE ELECTRICAL DEPARTMENT**
- BROWN: MAINTENANCE ON AUTOM. EQUIPMENT**
- RED: SURVEY, EXTERNAL SERVICE**

Appendix 2. Jobcard with Maintenance Descriptions (IMO Model Course 2.01)

Auxiliary Engine Planning Board

(Referred to section 6.2.1)

Appendix 3

(Referred to section 7.3.2)

VALIDATION OF THE COURSE

The information contained in the course, as IMO, has been validated by the sub-committee on Standards of Training and Watchkeeping for use by technical advisers, consultants and experts for the training and certification of the seafarers so that the minimum standards implemented may be as uniform as possible. Validation in the context of the document means that the sub-committee has found no grounds to object to its content. The sub-committee has not granted its approval to the document, as it considers that this work must not be regarded as an official interpretation of the convention.

In reaching a decision in this regard, the sub-committee was guided by the advice of a validation group comprised of representatives designated by ILO and IMO.

MODEL COURSES

Model 1. Thermodynamics and Heat Transmission

Model 2. Mechanics and Hydromechanics

Model 3. Operational Principles of Diesel Installations

Model 4. Operation and Maintenance of Machinery

Model 5. Physical and Chemical Properties of Fuels and Lubricants

Model 6. Technology of Materials

Model 7. Chemistry and Physics of Fire and Extinguishing Agents

Model 8. Marine Electrotechnology, Electronics and Electrical Equipment

Model 9. Fundamentals of Automation, Instrumentation and Control Systems

Model 10. Naval Architecture and Ship Construction

Model 11. Maritime Law, Agreements and Conventions

Model 12. Personnel Management, Organisation and Training

Model 13. Medical Emergency- First Aid

Model 14. Life Saving Appliances

Appendix 3 (cont.)

SYLLABUS AS SUBJECT

- **THERMODYNAMICS AND HEAT TRANSMISSION**

1. Steady-flow energy equation
2. First and second laws of thermodynamics
3. vapours
4. Behaviour of gases
5. Thermal efficiency
6. Steam plant
7. Nozzles
8. Engine trial data
9. Refrigeration
10. Heat transfer
11. Air compressors

- **MECHANICS AND HYDROMECHANICS**

1. Friction
2. Inertia
3. Circular Motion
4. Periodic Motion
5. Dynamics of rotation
6. Work and Energy
7. Impulse and Momentum
8. Hydrostatics
9. Hydraulics

- **OPERATIONAL PRINCIPLES OF DIESEL INSTALLATIONS**

1. Diesel Engines
2. Auxiliary Steam Boilers and Evaporators

Appendix 3 (cont.)

- **OPERATION AND MAINTENANCE OF MACHINERY**

1. Shafting
2. Pumps, Pumping Systems and Prevention of pollution
3. Steering Gear
4. Refrigeration and Air Conditioning

- **PHYSICAL AND CHEMICAL PROPERTIES OF FUELS AND LUBRICANTS**

1. Production of Oils from Crude Petroleum
2. Physical and Chemical properties of Oils
3. Combustion
4. Combustion equipment
5. Oil purification
6. Lubricating Oils
7. Lubrication
8. Lubrication problems and testing
9. Greases

- **TECHNOLOGY OF MATERIALS**

1. Metallurgy of Steel and Cast Iron
2. Testing and properties of Materials
3. Heat treatment of metals
4. Alloying elements in irons and steels
5. Non-ferrous metals
6. Non-Metallic Materials
7. Welding
8. Direct Stress and Strain
9. Strain energy
10. Stress in pressure vessels

Appendix 3 (cont.)

11. Shear and torsion.
12. Shear force and bending moments
13. Bending of beams
14. Combined bending and direct stress

- **MARINE ELECTROTECHNOLOGY, ELECTRONICS AND ELECTRICAL EQUIPMENT**

1. General Requirements
2. Applications of Ohm's and Kirchhoff's laws
3. Insulation and Temperature Rating
4. D.C. Generators
5. D.C. Switch gear
6. Electromagnetism
7. A.C. Circuit Theory
8. Parallel Circuits
9. Electronics
10. Power-factor Improvement
11. Polyphase Supplies
12. A.C. Generators
13. Automatic Voltage Regulation
14. A.C. Switchgear
15. Generator Protection
16. Single and Parallel Operation of Generators
17. Transformers
18. Rectification
19. Distribution
20. Protection
21. Cables
22. Motors

Appendix 3 (cont.)

23. Motor Control and Protection

24. Cells and Batteries

25. Lamps

26. Deck Machinery

27. Tankers

28. Electrical Interference

29. Insulation Testing

30. Graphical Symbols

31. Electric Shock

- **FUNDAMENTALS OF AUTOMATION,
INSTRUMENTATION AND CONTROL SYSTEMS**

1. General

2. Measurement of temperature

3. Measurement of Pressure

4. Measurement of level

5. Measurement of flow

6. Other measurements

7. Transmission of signals

8. Final controlling elements

9. Control Theory

10.Principles of pneumatic Control

11.Controllers

12.Control Circuits

13.Remote Control-diesel propulsion

14.Air supply

15.Monitoring Systems.

Appendix 3 (cont.)

- **NAVAL ARCHITECTURE AND SHIP CONSTRUCTION**

1. Movement of the centre of gravity
2. Flotation
3. Transverse statical stability
4. Effect of liquids on stability
5. Correcting an angle of loll
6. TPC and displacement curves
7. Form coefficients
8. Areas and volumes of ship shapes
9. KB, BM and metacentric diagrams
10. List
11. Moments of statical stability
12. Trim
13. Dry-docking and grounding
14. Damage Control
15. Ship motion
16. Vibration in ships
17. Rudders
18. Resistance, powering and fuel consumption
19. Propulsion and propellers
20. Ship structures.

- **MARITIME LAW**

1. Introduction to Maritime Law
2. Certificates and Documents required to be carried by international conventions and agreements
3. Safety
4. Pollution

Appendix 3 (cont.)

5. Maritime labour conventions and recommendations

6. Arrival Documents and Procedures

7. Classification Societies

8. Cargo

9. Law of the sea

10. National Maritime Legislation

- **PERSONNEL MANAGEMENT,
ORGANISATION AND TRAINING**

1. Personnel management

2. Organisation of staff

3. Training on board ships.

- **MEDICAL EMERGENCY**

-First aid

- **LIFE SAVING APPLIANCES**